

Darwin Initiative

Annual Report

1. Darwin Project Information

Project Ref. Number	14-030
Project Title	Going for Gold – <i>Cordyceps</i> Conservation in Bhutan
Country(ies)	Bhutan
UK Contractor	CAB International (CABI Bioscience)
Partner Organisation(s)	Council for Renewable Natural Resources of Bhutan (CORRB), Ministry of Agriculture, Bhutan
Darwin Grant Value	£204 936
Start/End dates	April 2005 – September 2008
Reporting period (1 Apr 200x to 31 Mar 200y) and annual report number (1,2,3..)	1 April 2005 – 31 March 2006; Annual Report no. 1
Project website	http://194.203.77.76/Cordyceps/
Author(s), date	Paul Cannon, May 2006

2. Project Background

Cordyceps sinensis is a fungus parasitic on Ghost moth (*Thitarodes*) caterpillars, widely distributed across the Tibetan plateau and adjoining areas of the eastern Himalayas. It is highly prized in Eastern traditional medicine with beneficial effects claimed to improve energy and general well-being, but it is also considered to boost the immune system, improve virility, benefit patients with heart and kidney problems, and it is used to treat hepatitis. The global market is difficult to estimate but probably runs into hundreds of millions of dollars, and it has been claimed that Bhutan supplies around 10% of the total natural market.

The Royal Government of Bhutan has put various conservation measures in place to protect the species and allow for sustainable harvest over the long term. It requested assistance from CABI to investigate the level of sustainable extraction, and other measures to protect the species and the fragile montane grasslands in which *Cordyceps sinensis* grows. The potential for farming using basic methods achievable by indigenous peoples in its natural habitat is also being addressed.

3. Project Purpose and Outputs

The project purpose is as stated in the logical framework:

“*Cordyceps sinensis* harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production.”

The main project outputs are as follows:

- Knowledge of *Cordyceps* incidence and harvest, host/parasite relations and host biology

- Monitoring/impact scheme designed and implemented in consultation with local stakeholders
- Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc
- Pilot project for low-tech *Cordyceps* farming in place
- Training and capacity building (fungal and insect biology, techniques)

No substantial changes to the outputs or operational plan have taken place over the past year. There have been some modifications in timing of events, but none has necessitated activity movement between project years and the overall programme has not been affected.

4. Progress

The project commenced formally with a five-week planning and orientation visit to Bhutan in May/June 2006 by two CABI staff members and an external consultant based in Thailand. This included liaison with various Government representatives, a 25-day field trip to select study sites and develop methods, an open project workshop to introduce the programme to a range of stakeholders, and agreement of a formal MoU between the project partners. Subsequent activities focused on two areas: field work to improve our knowledge of *Cordyceps* seasonality and biology of the host moth, and analysis of the Government-run auction process through which *Cordyceps* is sold. The seasonal nature of *Cordyceps* production means that activities are concentrated into the spring and summer, and activities during the autumn and winter period included background research, development of a *Cordyceps* leaflet, establishment of a website and a further planning meeting in Bangkok.

Progress over the first year has largely been as expected (see Annexe 1). Milestones for the literature review and website were not achieved on time. The literature review proved to be a much more extensive activity than planned for, meaning that it was not complete in time for the 2005 collection season. The priority then became availability to inform final field protocols that needed to be in place by May 2006 for the next field season, and subsequent competing priorities by our Chinese expert led to the task not finally being complete until March 2006. The delay has not had a deleterious effect on project progress. Regarding the website, our project partners requested a delay in implementation to allow them to review the information to ensure compliance with Government policy, and its inception followed discussion of a draft website during a project meeting in December 2005.

The principal additional output was the attendance of three Bhutanese project scientists on a one-week training course on insect-associated fungi in Thailand in August 2005. The course focused on improvement of knowledge of fungal biology and fungus/insect interactions, with practical instruction in collection and identification in Khao Yai National Park.

Project achievements April 2005 – March 2006

Fungus biology

Priorities identified included the requirement to understand population levels and the factors that influence them, seasonality (especially the dates of emergence and maturation). The first field trip included visits to five potential study sites in Soe-Yaksa and Lingshi districts. All are isolated, requiring a minimum of two and a half days travel on foot from the nearest roadhead with equipment transported by horse, and altitudes range between 4500 and 5000m. Survey and monitoring are arduous activities and require careful planning to ensure adequate supplies. *Cordyceps* sites occur in high-montane meadow dominated by *Kobresia* and *Festuca*, with dicots represented especially by *Bistorta*, *Potentilla* and dwarf *Rhododendron* species. Mammals include marmots and blue sheep, and most sites are grazed by yaks in the

summer months. Field work by CORRB staff continued after the initial study visit to build up a more comprehensive picture of *Cordyceps* life cycle and population level.

In 2005, most survey sites had very low levels of *Cordyceps* fruit bodies, with the exception of Rawana (above Lingshi). Distributions are highly patchy, but the site at Namna was surveyed in detail and yielded around one individual per 40m², in contrast to Rawana where the frequency was at least five times this level. Namna had been surveyed in previous years by CORRB staff when much higher population levels were encountered. It is likely that much of the variation can be explained by natural cycles in host/parasite prevalence, but there is concern that overcollection by legitimate collectors and poachers is having a deleterious impact. Survey work later on in the year established that mature *Cordyceps* were present in all study sites in July and August. This could be partially due to late emergence, but fruit bodies are very inconspicuous and it is likely that a proportion is missed by collectors. Studies in previous years and accrued anecdotal evidence suggest that emergence and maturity are strongly affected by weather conditions, with cold winters and springs delaying emergence. This is of especial significance as current Government policy is to protect stocks by restricting the period during which collection is legal.

Most of the work in the first project year was preparatory, developing protocols for monitoring populations. Guided by experiences in the first six months of the programme, we now have detailed survey protocols that will be implemented from May 2006, and agreed definitions of immature, semi-mature and mature *Cordyceps* to assist in the investigation of seasonality. We have agreed that the site at Namna will become the principal research area – it is the most accessible of the major sites surveyed and the local yak herder is particularly sympathetic to our activities. There are several minor sites within a short distance of Namna that will be monitored on a secondary basis.

Host biology

Knowledge of the host biology for *Cordyceps sinensis* is restricted, especially in Bhutan. Efforts were therefore expended to learn more about the life cycle and seasonality of the host moth. The research proved to be more problematic than anticipated. The moth caterpillars live in the ground feeding on plant roots, so a number of plots were dug over to extract them for observation and possible farming. This proved to be a highly strenuous exercise as the plant roots were found to be tough and highly matted, and only a small number of caterpillars were found. These belonged to several distinct instars, corroborating Chinese claims that they mature over more than one season. A selection of caterpillars were brought back to Yusipang (the CORRB centre near Thimphu) to investigate feeding preferences, but only a few survived the journey back to base and those that did succumbed before long. Likely reasons identified included physical damage caused by small stones etc. in the soil in which they were transported, and aggressiveness between caterpillars. A revised protocol will be used in following seasons.

Attempts were made to capture adult moths using light traps and sweep nets, but none were obtained and it was concluded that they were likely to fly later in the season than we anticipated. Further attempts will be made in 2006.

The low survival rate of caterpillars in captivity meant that initial attempts to investigate feeding preferences were limited. Information from the literature indicates that hepialid caterpillars are not highly plant-specific, and those captured were found to eat happily basic foods such as carrot. We do not yet know whether nutrition derived solely from carrot will allow them to complete their life cycle, so a task for the second year is to establish likely food plants in the experimental garden at Yusipang. A shortlist has been drawn up of species dominant in the area where caterpillars were captured. A small-scale experiment involving turf transplantation was also initiated.

Socioeconomic and regulatory research

Studies in this arena involved interviews with a range of families with grazing rights in the Jigme Jorji National Park to investigate their livelihoods, their dependence on *Cordyceps* harvest and their concerns about regulation and sustainability. For most the primary income was derived from yak herding and yak products (meat, butter, cheese and yak-hair ropes). In most cases the animals were actually owned by others (either individuals or monastic orders). Other sources of income include portering and collection of medicinal plants, but for many *Cordyceps* harvest represented a very significant secondary source of income.

Most were very happy to talk about their experiences of *Cordyceps* gathering, and appreciated that CORRB was working in their interests to safeguard supply in the long term. For many, very considerable efforts were expended in *Cordyceps* harvest, with family members away from home for days or even weeks and returning only to collect more food supplies. The major concern for almost all was unauthorized collection, primarily by Tibetans coming across the border and secondarily by people from lower regions of Bhutan. Collection is regulated so that only people who live or have grazing rights in a local region (geog) are allowed to collect, but there are widespread indications that the rules are broken. Park officials work with local communities to discourage poaching, but are frequently outnumbered; there were reports in 2005 of Tibetan poachers crossing the border in groups of 40-50.

A major secondary concern is that current Government regulations only permit *Cordyceps* collection in the month of June, while immature specimens (which actually command the best prices) are visible earlier in the year and this is when poaching activity is at its height. A number of suggestions were made to move the legal collection period forward to reward legitimate collectors and put greater pressure on the poachers, and we have been evaluating the conservation significance of this move over the winter. A stakeholder meeting at the end of April 2006 [and thus technically falling within year 2 of the project] revealed unanimous support for a change to mid May – mid June and we hope that the Government minister responsible will be able to announce the change in time for the 2006 collection season.

Cordyceps are traded in Bhutan via Government-organized auctions. 2005 was only the second year in which these have been held, and project staff were present at several auctions to learn lessons from the process. Some were much more successful than others, with those held in more remote regions attracting very few buyers, and in 2006 it is likely that the process will become more centralized. A major concern amongst the buyers was the poor quality of *Cordyceps* on sale, with many sellers offering mouldy, over-mature or broken specimens. An education programme has therefore been instigated to enable collectors to preserve their material more successfully, and a leaflet has been designed to explain the quality requirements. We anticipate that this will be distributed during the 2006 collection season.

Workplan April 2006 – March 2007

- April 2006** Stakeholder workshop to publicize sustainability concerns and to gather information from harvesters and buyers [already occurred]
- May 2006** Dissemination of leaflet on *Cordyceps* sustainability and quality
- May – August 2006** Survey and monitoring in Namna and surrounding areas to establish *Cordyceps* population size and seasonality
- May – July 2006** Establishment of potential host plants at Yusipang
- June – August 2006** Survey and study of host moths, including further attempts to rear caterpillars in captivity. To be continued if initially successful
- July 2006** Review of *Cordyceps* auction process and quality of material on sale; impact assessment of leaflet

5. Actions taken in response to previous reviews (if applicable)

- Not applicable.

6. Partnerships

Collaboration between project partners has been very good, with both sides remaining strongly committed to the purpose of the project. Signing of an MoU between CABI and CORRB at an early stage of the programme emphasizes both sides' wish for this to be a continuing collaboration, and I have received a number of assurances subsequently that CORRB continues to see significant benefits in our partnership.

There have been some frustrations along the way. The Royal Government has strict financial management measures in place to guard against corruption and these have led to delays in funds becoming available for use on the project. It is also highly time-consuming and bureaucratic to employ new staff even when funds are available, so existing staff tend to have many competing commitments. There have been occasional misunderstandings caused by culture differences, the Bhutanese people inherently being exceptionally polite and sometimes reluctant to disagree with plans put forward by partners. We have learnt from each other and concerns have been addressed positively by both sides.

A positive development has been funding of a related project on medicinal plants by the EU, focusing on sustainable harvest, cultivation and marketing. The two projects have good synergies, the Darwin project taking over much of the work originally planned on *Cordyceps* research by the EU programme, and the latter project assuming some responsibility for IP and trade issues in *Cordyceps*. CORRB are local partners for both programmes, and are working hard to maximize cross-benefits.

7. Impact and Sustainability

Cordyceps has a high profile within many Bhutanese communities, though at the beginning of the project interest by many was focused primarily on its value and the threats to livelihoods caused by poaching. The Royal Government of Bhutan closely reflects the King's well-known concern for the environment and sustainable development. Its officers are very receptive to messages from the project, and are concerned that policy changes are underpinned by sound science. Institutionally, therefore, the project is pushing at an open door; the challenge is to ensure that messages about sustainability are understood by the lay public.

Our approach is to generate a win-win situation by emphasizing the need to restrict collection (the cautious approach while data on population levels and collection impact are being generated) through adherence to the legal collection period. Simultaneously, we are also assisting collectors to gain higher prices for the material they do gather through better preservation and presentation. Sustainability is also being addressed through advice to collectors not to remove mature specimens that are releasing spores to infect the next generation of caterpillars. These have high biological but low commercial value.

Several steps have been taken to date to promulgate these messages, and these will be built upon in later stages of the project. The sustainability message has been advertized through coverage in the national newspaper *Kuenzel*, initially following the project inception workshop and again recently when reporting on the stakeholder workshop held in April 2006. That was also covered by the national television service and by an independent local film-maker, with sustainability featuring as an issue in the subsequent broadcast.

An illustrated leaflet has been designed to provide collectors with information enabling them (a) to understand that *Cordyceps* is not an inexhaustible natural resource, (b) to collect at the right time of year, (c) to differentiate between immature and mature specimens, and (d) to improve quality by adopting best-practice post-harvest treatments. This will initially be printed in English (which is widely spoken in Bhutan) and focused on National Park staff, village headmen etc., and we also plan a version in Dzongka for dissemination to the collectors themselves.

Another important means of dissemination of project knowledge will be verbally, through presentations at the *Cordyceps* auctions and other relevant events, and via word of mouth using National Park staff and gups (village leaders) as information providers. The leaflets will assist them to convey the correct messages, and we shall make efforts to mobilize these people to pass on knowledge.

The work has also been the subject of public interest outside of Bhutan. A news article in the *New Scientist* in summer 2005 based on a CABI press release stimulated stories in the *Observer*, and the *Sunday Telegraph* also published a piece linking (probably erroneously) increased trade in snow leopard pelts with improved livelihoods caused by income from *Cordyceps*. An Australian television company has approached us with the aim of producing a television film on *Cordyceps* and snow leopard conservation, and the BBC Natural History Unit has also made enquiries for a programme on China to be broadcast in 2008. A poster for the project was also featured at a conservation symposium in Cambridge in March 2006.

The value of trade (and income to the Royal Government; a 10% levy is charged to the buyer during the auction) mean that we are confident that *Cordyceps* will remain a high priority target for conservation and sustainability in Bhutan. We shall not be able to provide all the answers during the programme (for example, the legal collection dates ideally need to be linked to weather conditions as well as the calendar, and it will take at least ten years to acquire statistically significant supporting data), but we shall provide the tools to achieve this long-term goal. We are confident that the Government has suitable human resources to continue the research.

8. Outputs, Outcomes and Dissemination

Project implementation timetable			
<i>Date</i>	<i>Key milestones</i>	<i>Date achieved</i>	<i>Any adverse impact?</i>
<i>May 2005</i>	<i>Memorandum of agreement between all partners signed</i>	Agreed by CABI and CORRB June 2005, formally in place September 2005 following sanction by Ministry of Agriculture	None
<i>May 2005</i>	<i>Production of full literature review on Cordyceps and host biology, to take account of Chinese research.</i>	Partially complete May 2005, major upgrade March 2006	Minimal
<i>June 2005</i>	<i>Project inception meeting for Government representatives etc.</i>	June 2005	As planned
<i>June 2005</i>	<i>Introductory meeting to establish collaboration with NP stakeholders</i>	June 2005	Combined with above event
<i>June 2005</i>	<i>Selection of study sites</i>	Initial selection June 2005, confirmed December 2005	None

<i>August 2005</i>	<i>Development and trialling of survey protocols</i>	Initial trials July/August 2005, protocols updated April 2006 August 2005	As planned
<i>September 2005</i>	<i>Website launched</i>	December 2005	Additional output Minimal
<i>March 2006</i>	<i>Annual report</i>	May 2005	

Project outputs			
<i>Date</i>	<i>Standard output no.</i>	<i>Description</i>	<i>Achieved</i>
June 2005	14	Inception meeting with Government officials	Yes
June 2005	15A	1 national press release in Bhutan	Yes
June 2005	14	First meeting with NP stakeholders	Yes
June 2005	6A	Training in methodology for 3 project staff	Yes
July 2005	15C	1 national press release in UK	Yes
October 2005	7	1 Leaflet on Cordyceps sustainability issues	Yes (later than planned due to need for consultation; see programme description above)

Dissemination activities have been described in section 7 above.

Table 1. Project Outputs (According to Standard Output Measures)

Code No.	Description	Year 1 Total	Year 2 Total	Year 3 Total	Year 4 Total	TOTAL
6A/B	1-week training course on insect fungi for 3 Bhutanese scientists	3				
7	Education leaflet, poster, website	3				
8	Person/weeks spent abroad on project work	17				
14B	Conservation conference, Cambridge March 2006, Darwin workshop	2				
15A	National press release/article in Bhutan	1				
15C	National press	2				

	release/article in UK	
20	Value of assets	£1500
23	Matching funding from EU Medicinal Plants project (estimated)	£8000

Table 2: Publications

Type * (e.g. journals, manual, CDs)	Detail (title, author, year)	Publishers (name, city)	Available from (e.g. contact address, website)	Cost £
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[None produced as yet]

9. Project Expenditure

- Please expand and complete Table 3.

Table 3: Project expenditure during the reporting period (Defra Financial Year 01 April to 31 March)

10. Monitoring, Evaluation and Lessons

Monitoring and evaluation has proceeded primarily through comparison of results with the log frame and project outputs. This has involved written reports for all significant activities, compiled primarily by myself for joint activities and by CORRB for independent field work etc. There has also been regular email exchanges during the periods that UK-based experts were not in Bhutan.

Further confirmation that the work carried out has been aimed in the right direction has come from comments and responses from a range of Bhutan-based organizations independent of the project. The best example of this technically

occurred at the beginning of Year 2 during the stakeholders' workshop held at the end of April 2006, and there a remarkable degree of consensus was achieved between nature conservation staff, agricultural marketing specialists, regulatory authorities, collectors' representatives and *Cordyceps* buyers. All agreed that the activities described under the auspices of the Darwin project constituted an important step along the road to achieving sustainable harvest, and encouraged us to continue our research along the lines planned.

Lessons learnt have been many, especially for the project leader who had not visited Bhutan previous to the current project. Perhaps the most important lesson relates to the way in which Bhutan is governed. Democracy is being gradually introduced as a benevolent and revered monarch transfers power to Government agencies. The very high profile afforded to the environment and sustainable development, combined with the Buddhist religion, has resulted in very widespread respect for the natural world. The Bhutanese people would not consider themselves as saints, but in these circumstances the potential for achieving sustainability of *Cordyceps* harvest must be relatively high, assuming that external poaching can be controlled. Achievement of the project purpose would be immensely more difficult without the strong lead given by the ruling bodies.

11. OPTIONAL: Outstanding achievements of your project during the reporting period (300-400 words maximum)

■ **I agree for ECTF and the Darwin Secretariat to publish the content of this section**

The project is at an early stage, so we would prefer not to contribute this year.

Annex 1 Report of progress and achievements against Logical Framework for Financial Year: 2005/2006

Project summary	Measurable Indicators	Progress and Achievements April 2005-Mar 2006	Actions required/planned for next period
<p>Goal: To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve</p> <ul style="list-style-type: none"> • The conservation of biological diversity, • The sustainable use of its components, and • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources 			
<p>Purpose <i>Cordyceps sinensis</i> harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production</p>	<ol style="list-style-type: none"> 1. New knowledge on population and harvest levels, host/parasite relations and host requirements 2. Monitoring/impact scheme in place 3. Local stakeholders in support of conservation 4. Feasibility study and pilot programme for <i>Cordyceps</i> farming 5. Regulatory system in place/modified appropriately, leading to reduction in illegal harvest 	<p>Progress has been made towards achieving all of these purpose statements.</p>	<p>Lessons learnt at this stage have been largely practical, understanding the logistical difficulties of fieldwork in Bhutan. In particular the pilot programme for <i>Cordyceps</i> farming is proving more problematic than anticipated. But see also the statement in section 10 above.</p>
<p>Outputs</p>			
<p>Knowledge of <i>Cordyceps</i> incidence and harvest, host/parasite relations and host biology</p>	<p>Reports published and circulated to Government and other stakeholders</p>	<p>Preliminary studies complete, experimental protocols and priority tasks agreed</p>	<p>Further studies of host biology and seasonality</p>
<p>Monitoring/impact scheme designed and implemented in consultation with local stakeholders</p>	<p>National Park and NCD/CORRB staff trained, harvesters/ traders mobilized, monitoring in place</p>	<p>Monitoring programme designed and in place</p>	<p>Monitoring programme implemented from spring 2006</p>

Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc	Leaflets and policy documents produced, stakeholder meetings taken place	Initial review of regulatory system completed in partnership with stakeholders, best practice leaflet designed	Stakeholder meeting to review current regulatory structure, dissemination of best practice, obtaining of feedback, further review of auction process
Pilot project for low-tech Cordyceps farming in place	Experimental farm set up, caterpillars raised successfully, inoculation with fungus achieved	Initial studies carried out	Initial attempts at caterpillar cultivation unsuccessful, may prove more problematic than expected.
Training and capacity building (fungal and insect biology, techniques)	Number of National Park, NCD/CORRB staff participating	[Primary activities planned for years 2-3]	Training days implemented assuming timing issues can be resolved

Note: Please do NOT expand rows to include activities since their completion and outcomes should be reported under the column on progress and achievements at output and purpose levels.

LOGICAL FRAMEWORK

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Goal:</p> <p>To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve</p> <ul style="list-style-type: none"> the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilisation of genetic resources 			
<p>Purpose</p>			
<p>Cordyceps sinensis harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production</p>	<ol style="list-style-type: none"> New knowledge on population and harvest levels, host/parasite relations and host requirements Monitoring/impact scheme in place Local stakeholders in support of conservation Feasibility study and pilot programme for Cordyceps farming Regulatory system in place/modified appropriately, leading to reduction in illegal harvest 	<ol style="list-style-type: none"> Reports by National Park, NCD/CORRB and project partners, scientific papers Protocols & survey reports Participation by local population Reports by project partners Regulatory system publicised via meetings, leaflets, liaison with traders etc.; reports from regulatory authorities 	<ol style="list-style-type: none"> Government continues to give high priority to Cordyceps sustainability Local people support sustainability programme Illegal poaching controlled National agencies liaise effectively
<p>Outputs</p>			
<p>Knowledge of Cordyceps incidence and harvest, host/parasite relations and host biology</p>	<p>Reports published and circulated to Government and other stakeholders</p>	<p>Reports sent to Darwin Initiative, scientific papers, habitat management plan</p>	<p>Sufficient information acquired, seasonality issues successfully addressed</p>
<p>Monitoring/impact scheme designed and implemented in consultation with local stakeholders</p>	<p>National Park and NCD/CORRB staff trained, harvesters/traders mobilized, monitoring in place</p>	<p>Reports and feedback from trainees and institutions, monitoring results collated /sent to Darwin Initiative</p>	<p>Local stakeholders agree to programme, good liaison with National Park and NCD/CORRB</p>
<p>Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc</p>	<p>Leaflets and policy documents produced, stakeholder meetings taken place</p>	<p>Records of meeting attendance, documents sent to Darwin Initiative</p>	<p>Appropriate authorities liaise to modify regulation, stakeholders on board, effective enforcement of regulation occurs</p>
<p>Pilot project for low-tech Cordyceps farming in place</p>	<p>Experimental farm set up, caterpillars raised successfully, inoculation with fungus achieved</p>	<p>Reports of progress, farmed Cordyceps available</p>	<p>Information on food plants available, food plant cultivation achieved, caterpillars successfully transferred to farm, inoculation with Cordyceps</p>

			successful
Training and capacity building (fungal and insect biology, techniques)	Number of National Park, NCD/CORRB staff participating	Training materials available, student and manager feedback forms	Suitable staff released for training, staff able to put training into practice
Activities			
Design and implement surveys to quantify Cordyceps habitat, distribution and patterns of exploitation. Investigate yak grazing patterns. Develop methods to locate and survey Lepidoptera host. Develop methods to collect and breed / rear Lepidoptera host (from adult, egg or larval stage). Conduct direct observations of Lepidoptera feeding behaviour and life-cycle and study caterpillar / fungus interactions under field / experimental conditions.		Design surveys and evaluate techniques, year 1. Habitat and exploitation survey years 1-4. Collect host adults (for eggs) and caterpillars from year 1 and continue annually through project. Conduct feeding & life-cycle observations years 1-4. Caterpillar / fungus interaction studies years 2-3.	
Plan and implement policies to maximise participation of local stakeholders. Publicise concept of sustainability. Set up monitoring team and train field surveyors in stakeholder interview, habitat assessment and Lepidoptera survey techniques.		Participatory programme planned year 1. Project introduction meeting to engage local stakeholders by promoting concept of sustainability and inviting stakeholder discussion of community problems and solutions, year 1. Monitoring team established and trained year 1. Implementation of monitoring, years 1-4	
Propagate food plants and grow in experimental garden. Trial alternative food sources for caterpillars. Construct suitable rearing cages and introduce caterpillars. Inoculate caterpillars with Cordyceps. Produce new fungus fruiting bodies.		Food plants propagated and grown in experimental garden, year 2; alternative and conventional food sources offered in year 2 and effect on larval growth, survival and ability to host Cordyceps studied years 2-4; suitable cages built, caterpillars introduced, years 1-4; results of inoculation with Cordyceps assessed, year 3; new fungi produced, year 4.	
Produce training materials; design and run training days on fungi and insects for stakeholders. Elicit trainee feedback.		Training days on fungi and insects, years 2-3.	
Review current regulatory system and modify in the light of research findings, in collaboration with stakeholders at key stages. Develop a strategy to enforce the modified regulatory system.		Current regulatory system reviewed and modifications drafted as agreed/appropriate, year 3. Development of enforcement strategy, years 3-4.	